basis for all linear measurements throughout that vast empire. The inch carried by the English settlers to Jamestown in 1607, and that taken by the English carpenters to St. Petersburg in 1698 were the same; and the Russian emigrant, landing in America in 1905, finds the linear measurements of his new home commensurable with those of the land he has left.

Compare this uniformity of popular usage with the chaos of incommensurable standards wherever the metric system has been forced by law into conflict with the old standards of the people. One is the result of English evolution; the other, of French revolution.

SAMUEL S. DALE.

BOSTON, MASS.,
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SPECIAL ARTICLES.

DETERMINATE MUTATION.

AMONG the significant results obtained by Professor de Vries in his breeding of *Œnothera lamarckiana,* and by Dr. MacDougal breeding the same species in the New York Botanical Garden, there is one feature which seems to have attracted less attention than it may deserve. Most of the seven mutants observed by de Vries, and of the thirteen seen by MacDougal, have appeared more frequently than would be natural were the mutations wholly fortuitous and indeterminate.

In the Amsterdam garden the mutant *albida* appeared in four different generations from *lamarckiana* parents, previous to 1902, 15 *albida* appearing in one generation, 25 in another, 11 in another and 5 in another. *Nanella* appeared 5 times in one generation, and in other generations, respectively, 3, 60, 49, 9, 11 and 21 times. *Lata, oblonga rubrinervis* and *scintillans* appeared frequently.

In the fourth generation along with 14,000 *lamarckiana* plants there appeared 41 *gigas,* 15 *albida,* 176 *oblonga,* 8 *rubrinervis,* 60 *nanella,* 63 *lata* and 1 *scintillans,* all bred from *lamarckiana* seed. In the fifth generation, similarly bred from pure *lamarckiana* seed, among 8,000 *lamarckiana* plants were found 25 *albida,* 135 *oblonga,* 20 *rubrinervis,* 49 *nanella,* 142 *lata* and 6 *scintillans.* In the fourth generation one plant in 80 was *oblonga.* In the fifth generation one plant in 60 was *oblonga.* De Vries himself says: "A species, therefore, is not born only a single time, but repeatedly, in a large number of individuals and during a series of consecutive years."

De Vries writes of *Œnothera oblonga:*

> Meist etwa sechsten Blatte sind die jungen Pflänzchen dieser Art mit Sicherheit zu erkennen, also etwas später als *O. lata* und *O. nanella,* und wesentlich früher als *O. rubrinervis* und *O. scintillans.* Die Blätter sind schmal, lang gestielt, ziemlich scharf vom Stiele abgesetzt, mit breiten, blassen, auf der Unterseite oft röthlichen Nerven. In Aussaaten sind die *O. oblonga* nur bei sehr weitem Stande früh und gleichzeitig zu erkennen, aber wenn man in den Versuchen von Zeit zu Zeit die unzweifelhaften *oblonga*-Exemplare auszieht, so zeigen sich die Merkmale bald in weiteren und weiteren Individuen, ohne dass diese dazu viel Raum brauchten.
>
> In den ausgepflanzten Rosetten erhält sich die angegebene typische Blattform. Einige Exemplare treiben Stengel, andere werden zweijährig. In beiden Fällen bleiben die Pflanzen niedrig, erreichen kaum 1 m Höhe und sind auffallend kleiner, als die in derselben Weise cultivirten Exemplare von *O. Lamarckiana.* Die einjährigen verzweigen sich wenig. Die Zweige bleiben meist kurz, Die Aehren sind dicht mit Blüthen und Knospen besetzt; die Blüthen kleiner als bei *O. Lamarckiana,* sehr arm an Blüthenstaub und nur ganz winzige Früchtchen mit wenigen Samen aussetzend. Die zweijährigen verzweigen sich kräftiger und sind mit Pollen reichlich versehen; sie bilden zwar kurze, aber dicke Früchte, welche eine reiche Samenernte geben.
>
> Bei fortschreitender Blüthe erkennt man die *oblonga*-Exemplare schon von Weitem an den dichtgedrängten, aber kleinen unreifen Früchten.

This mutant, therefore, differs from the parent species, *lamarckiana,* not in a single feature, but in an elaborate complex of characters. The other mutants likewise are distinguished from *lamarckiana* by a complex of characters rather than by a single feature. Speaking of the contrast between reversions and progressive mutations, de Vries says:

* * * ordinarily they [reversions] deviate from the species in but a single character * * * . Quite different from this are the mutations of *Œnothera*. Recognizable as seedlings, as rosettes differing in shape, edge and color of the root-leaves, and later with stems differing in structure and mode of branching, agreeing in the flowers, varying in the fruits, they possess a type entirely their own * * * .

The mutations can hardly be entirely fortuitous if, for several generations, out of every thousand offspring of pure *lamarckiana* parents, there appear more than ten plants marked by the particular complex group of characters which designate *oblonga*. Were *oblonga* demarcated from *lamarckiana* by but a single character it would be remarkable to find it appearing repeatedly and in such numbers. When we remember that it is defined by an extensive series of characters differentiating it from *lamarckiana* and from all the other mutants observed, are we not led to the conclusion that mutation in *Œnothera lamarckiana* is not wholly fortuitous, but is to a degree predetermined; that there is some tendency to the production of the *oblonga* and other types in numbers much greater than would be secured by purely fortuitous and indeterminate mutation?

It seems of much interest that the evidence from paleontology in favor of determinate variation (or mutation) should be borne out by such careful observations as those of de Vries in so different a field of research.

I confess I do not quite understand Professor De Vries's statement—'In my experiments the mother species mutates *in all directions* [italics mine], in nearly all organs and characters, as well as for better or worse." I can not see that the published descriptions of his observations do show mutation in all directions. They seem to show rather the continued reappearance of but a few (7) distinct types of mutation. To be sure, MacDougal finds thirteen instead of seven of these mutants from *Œnothera lamarckiana*, but this is far from mutation in all directions. De Vries apparently meant merely to urge that the mutations were in several different directions and were such as could hardly be due to direct environmental influences, and not to claim that the mutations were purely fortuitous and indeterminate.

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CURRENT NOTES ON METEOROLOGY.

THE TEACHING OF METEOROLOGY.

PROFESSOR CLEVELAND ABBE, of the U. S. Weather Bureau, delivered an address upon 'The Introduction of Meteorology into the Courses of Instruction in Mathematics and Physics,' before the Physics and Mathematics Section of the Central Association of Science and Mathematics Teachers, on November 26 last. This address has now been reprinted, and constitutes a strong plea for more instruction along meteorological lines in various courses in mathematics and physics in which meteorological problems could well be dealt with. Professor Abbe regards meteorology 'not so much a matter of observation and generalization as matter of deductive reasoning,' and rightly believes that our meteorological studies have *approached*—he does not say *reached*—the limit of what is likely to be discovered as the result of inductive processes. He does not suggest the introduction of a new study into the already overcrowded curriculum of schools and colleges, but he would have problems in mathematics and physics selected from among the many phenomena of the atmosphere which need investigation. Thus, among a few special subjects which are enumerated, we find the simpler applications of trigonometry in the determination of cloud heights and velocities, by means of the simpler methods, such as Lambert's and Feussner's, and by the use of the theodolite, photogrammeter and nephoscope; the theory of the wet bulb thermometer; the hypsometric formula of Laplace; thermometer corrections; the formation of a waterspout by Weyher's method; and the study of the wind velocity, pressure, temperature and dimensions of the cloud column. Professor Abbe's paper is suggestive, and points the way toward a considerable possible extension of sound meteorological education by utilizing the mathematical and physical machinery already in operation.